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Report to the Honorable Barbara Boxer, House of Representatives

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BRADLEY VEHICLE

Status of the Army's Survivability Enhancement Program

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GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

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May 21, 1990

The Honorable Barbara Boxer
House of Representatives

Dear Ms. Boxer:

This report responds to your request that we provide you with information on the current status of the Army's modification program for enhancing the survivability of the Bradley Fighting Vehicle. We briefed your staff on the results of our work on March 5, 1990.

Results in Brief

As a result of live-fire testing conducted between March 1985 and May 1987, the Army is incorporating a number of survivability enhancements into a new Bradley high-survivability configuration referred to as the "A2 model." This model will be produced in two versions: the Infantry Fighting Vehicle (IFV) and the Cavalry Fighting Vehicle (CFV). Enhancements will include (1) the addition of armor to provide protection against 30-mm projectiles, (2) the addition of liners inside the turret to protect the crew from high-velocity debris (spall) resulting from rounds' penetrating the crew compartment, (3) the addition of armor to protect against antitank chemical energy weapons (this armor is to be provided to field troops when it is developed), (4) changes in the way fuel and ammunition are internally stored, and (5) changes to the vehicle's automatic fire extinguishing system. Because of the weight increases associated with these changes, the Army is upgrading the Bradley power train with a 600-horsepower engine and a modified transmission. Production unit costs (in fiscal year 1989 constant dollars) to the IFV will increase by $117,489 and to the CFV by $124,789. In addition, 2,033 Bradley vehicles already fielded will be retrofitted.

Background

Each version of the Bradley Fighting Vehicle performs a different mission: the IFV supports the infantry, and the CFV supports the cavalry. The IFV's mission is to transport the infantry squad into battle and, once there, to support the squad and the accompanying tanks by suppressing enemy infantry and lightly armored vehicles. The CFV's mission is to perform reconnaissance for the armored cavalry. Each version of the vehicle has a 25 mm-cannon; a Tube-Launched, Optically-Tracked, Wire-Guided (TOW) antitank guided missile launcher; and a coaxial machine gun. Both the IFV and the CFV were initially armored to withstand hits from up to 14.5-mm ammunition.

Because of concerns about the Bradley's vulnerability, the Army conducted a series of live-fire vulnerability tests from March 1985 through May 1987. The tests showed that the Bradley, as then configured, was highly vulnerable to anti-armor weapons. The Office of the Secretary of Defense, in December 1987 hearings, reported to the Subcommittee on Procurement and Military Nuclear Systems, House Committee on Armed Services, that because of live-fire test results, the Army planned to incorporate a number of modifications designed to reduce the Bradley's vulnerability.

Status of Planned Changes to the Bradley Vehicle

The Army has made or is planning to make the survivability-enhancing modifications discussed in the 1987 hearing. In addition, to accommodate the heavier weight associated with these modifications, the Army has incorporated a higher horsepower engine and a modified transmission into the new high-survivability (A2) configuration. The survivability modifications are as follows:

- Steel applique armor. This armor, consisting of steel plates added to existing armor on parts of the turret and hull, increased protection from 14.5-mm to 30-mm ammunition.
- Spall liners. Spall liners were added to the interior of the crew compartment to protect the crew from high-velocity debris (spall) caused by rounds' penetrating the vehicle.
- Relocation of ammunition. Twenty-five millimeter ammunition and TOW missiles stowed internally were moved to less vulnerable areas located in the rear, lower part of the crew compartment. In addition, to the extent possible, mines and pyrotechnics (signals and flares) were stowed in external rear stowage compartments.
- Attachment points. Attachment points were added to the exterior of the vehicle (the front, sides, and turret) for the purpose of attaching reactive or passive armor tiles.
- Reactive or passive armor tiles. These tiles will be bolted to the prefixed attachment points on the exterior of the vehicle to provide protection against shaped-charged (chemical) warheads used in antitank guided weapons. The Army initially reported that it planned to add reactive armor. However, because of advances in passive armor, the Army has decided that passive armor may be a viable alternative for the required armor protection. Reactive armor explodes outward when hit by a chemical missile, neutralizing most of the warhead's force. Passive armor blunts the warhead's forces but does not explode outward when hit. The Army plans to award up to three development contracts in June 1990 and will select the eventual production contractor on the

basis of competitive tests. The competitive testing is scheduled to be completed and a production contract awarded by May 1991, with the armor tiles released to the troops 2 years later in May 1993.

- Automatic fire extinguishing system. This system will be modified to incorporate a dual-shot system, which automatically activates after a 1/2-second delay to protect against a second hit. To further protect the system, cables were rerouted and spall protection added.
- Engine. The engine's power was increased from 500 to 600 horsepower to accommodate the heavier vehicle weight resulting from survivability modifications.
- Transmission. The transmission was modified to improve reliability and to match the horsepower increase of the engine.
- Internal fuel supply system. This system was modified to exhaust fuel from vulnerable upper fuel cells before fuel from the more protected lower fuel cells is used (upper fuel cells will be emptied after the first 40 gallons of fuel are burned).

Production Status and Cost of Survivability Modifications

The estimated production unit cost in fiscal year 1989 dollars will increase $117,489 for the IFV and $124,789 for the CFV. Production cut-in dates and unit cost increases or decreases of the individual modifications are shown in table 1.

Table 1: Production Cut-In Dates and Cost Increases and Decreases for the Bradley's Enhancements

In fiscal year 1989 constant dollars

Modification	Date of production cut-in	Unit cost change for the IFV	Unit cost change for the CFV
Addition of steel applique armor, addition of spall liners, relocation of ammunition, and addition of attachment points for armor tiles	May 1988	$53,199[a]	$60,508[a]
Addition of armor tiles (reactive or passive)	To be determined	62,419	62,419
Addition of dual-shot fire extinguishing system	October 1991	3,855	3,855
Addition of 600-horsepower engine	May 1989	2,528	2,528
Modification of transmission	May 1989	(6,005)[b]	(6,005)[b]
Changes to fuel system	May 1986	1,129	1,129
Rerouting of fire extinguishing system cables	May 1986	364	364
Total		**$117,489**	**$124,789**

[a]The cost of each individual modification is not available.

[b]These savings are attributable to a multiyear contract to produce transmissions.

Bradley Fighting Vehicle System Retrofit Program

The Army plans to retrofit 2,033 of 4,333 Bradleys to the high-survivability (A2) configuration. It does not plan to retrofit the first 2,300 Bradleys produced because it believes that retrofitting these vehicles would be too costly. Of the 2,033 Bradleys, 662 are the new A2 model without the upgraded engine and transmission. These A2s will be retrofitted with the new power pack. The remaining 1,371 Bradleys will be retrofitted with all survivability enhancements except the dual-shot automatic fire extinguishing system. The retrofit schedule for this system has not yet been established. The Army has three Product Improvement Programs for upgrading the Bradley. The programs and their estimated unit costs are shown in table 2.

Table 2: Product Improvement Programs and Cost

In fiscal year 1989 constant dollars

Product Improvement Program	Unit cost for the IFV	Unit cost for the CFV
High-survivability modification Addition of steel applique armor Addition of spall liners Relocation of ammunition Addition of armor tile attachment points	$168,837	$168,312
New 600-horsepower engine	34,532	34,532
Modification to transmission	24,917	24,917
Total	**$228,286**	**$227,761**

Note: The total costs of the Product Improvement Program do not include new production costs of the reactive or passive armor tiles that are currently estimated to cost $62,419 per vehicle.

The retrofit conversion schedule is shown in table 3.

Table 3: The Bradley's Retrofit Conversion Schedule

Bradley model	Fiscal year 1990	1991	1992	1993	1994	Total
A1 configuration (upgraded to A2 high-survivability configuration)	54	239	395	443	240	**1,371**
A2 high-survivability configuration (addition of upgraded power train)	249	292	121	0	0	**662**

Objective, Scope, and Methodology

We obtained pertinent documentation on survivability modifications to the Bradley, including current cost and development and production schedules. We also held discussions with program officials from the Bradley Fighting Vehicle System Office in Warren, Michigan. We conducted our review between November 1989 and February 1990 in accordance with generally accepted government auditing standards.

As requested, we did not obtain official agency comments on this report. However, we discussed the information we gathered with Army and Department of Defense officials and incorporated their views when appropriate.

As arranged with your office, we are sending copies of this report to the Chairmen of the House and Senate Committees on Armed Services and on Appropriations and the Secretaries of Defense and the Army. Copies will also be made available to other parties upon request.

Major contributors to this report were Jim Shafer, Assistant Director; Bob Herman, Evaluator-in-Charge; and Don Warda, Staff Member. Please contact me at (202) 275-4141 if you or your staff have any questions concerning this report.

Sincerely yours,

Richard Davis

Richard Davis
Director, Army Issues

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